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DISTRIBUTION OF THE UTAH CHUB (GILA ATRARIA)
IN THE
UPPER MISSOURI RIVER SYSTEM

Prepared for
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ABSTRACT

Distribution of the Utah chub (Gila atraria) was studied on the upper Missouri River system between Hebgen Lake on the Madison River and Morony Dam at Great Falls. Field work was done May through September 1978. The Utah chub was found to be well established throughout the length of the Madison River. A weak population of Utah chub has been established in the southern (upstream) end of Canyon Ferry Reservoir. Single Utah chub specimens were collected in Hauser Lake and Lake Helena. No Utah chubs were collected downstream from Hauser Dam, through the river system to Morony Dam. Downstream dispersal rates based on the distance from Hebgen Lake to Hauser Dam (312.7 km) ranged from 8.9 km/year for a 1970 Utah chub collection in Hauser Lake to 7.3 km/year for the collection made in this study. Adult Utah chubs were generally captured in areas of reservoirs where rooted aquatic plants were lacking, water depths were less than 3 m, and substrates were composed of rocky or sandy gravel. The Utah chubs sampled in Canyon Ferry Reservoir and Hauser Lake were found in dredged areas of the reservoirs.



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INTRODUCTION

The Utah chub (scientific names of fish are given in Appendix A) was native to the Bonneville Basin in Utah and the Snake River above Shoshone Falls in Wyoming (Baxter and Simon 1970). In Montana, the Utah chub has been limited to the upper Missouri River basin and has not been reported from the Yellowstone and Milk River basins, nor from waters on the west side of the Continental Divide.

Around 1935, the Utah chub was introduced into the upper Missouri River system at Hebgen Lake on the Madison River (Graham 1954). Live bait fishermen were suspected of making the introduction. Similarly, the Utah chub was introduced into the Green River in Wyoming and the Colorado River in Utah. Following introduction, this fish was able to compete successfully and in many cases became the dominant species in the new environment.

High fecundity, and generalized food, reproductive, and habitat requirements provide the Utah chub with the potential to build dense populations. Lakes and streams where the species has become a problem are either not within the chub's native range, or if so, have been much modified by man (Sigler and Miller 1963). Lack of recreational and commercial fishery value compounds the predicament of managing expanding chub populations (Brown 1971, Baxter and Simon 1970).

Fish indigenous to the upper Missouri River system could gain access to Canadian waters as a result of irrigation under the Garrison Diversion Unit in North Dakota (International

Garrison Diversion Study Board 1976). The Utah chub was identified as a potential problem species. The Study Board concluded that the Utah chub could eventually inhabit the upper Missouri River to Lake Sakakawea, disperse through the diversion unit, become established in Canada, and reduce Canadian recreational and commercial fisheries for native species.

Concerned about possible interbasin chub movements, the United States Department of the Interior, Bureau of Reclamation contracted the Montana Fish and Game Department to study Utah chub distribution in Montana's upper Missouri River basin. A single objective was defined: Determine the distribution of the Utah chub in lake and reservoir habitats, major slough, and backwater areas from Hebgen Lake to Holter Lake. The study area was later expanded to include the Missouri River from Holter Dam through the reservoir system at Great Falls to Morony Dam.

A brief literature review prefaces this report and provides background information on Utah chub life history.

LIFE HISTORY

Habitat

The Utah chub has very generalized habitat requirements, and thrives over a wide range of temperature and water types. It can be found in cooler water, ranging from 15-20°C in the summer, or in warmer 27-31°C water (Sigler and Miller 1963). Preferring slower moving or still water, the Utah chub is common in springs, irrigation ditches, ponds, sloughs, creeks,

rivers, lakes and reservoirs over its present range (Baxter and Simon 1970, Brown 1971, Sigler and Miller 1963).

The amount of cover utilized by this fish depends largely on the season, age of the fish, and on the availability of suitable cover. Fry typically school along protected shorelines, using rooted aquatic vegetation and inundated terrestrial plants as nursery areas (Varley and Livesay 1976, Graham 1961). Age I+ and II+ Utah chubs in Flaming Gorge Reservoir (Wyoming - Utah) began to wander into deeper waters during daylight hours when predation by salmonids was minimized (Varley and Livesay 1976). However, some authoror felt that younger chubs ventured to deeper water at night and remained in shallow water during daylight hours (John 1959). In either case, most authors agreed that young Utah chubs through age II+ remained closely associated with vegetation or other escape cover.

Around age III+, Utah chubs are recruited to the adult population. Other than during spawning, adult chubs are found in littoral and pelagic waters, often in schools of variable size. Some evidence exists indicating adult Utah chubs are territorial, and do not readily migrate from one area to another (Olsen 1959, John 1959, both cited by Varley et al. 1976).

Maturity

In general, male Utah chubs begin to mature sexually in their third year, and females in their fourth year (Varley

and Livesay 1976, Graham 1971, Gaufin 1964, Olsen 1959).

Most researchers reported at least a small percentage of ripe three-year old chubs, however, in Two Ocean Lake, Wyoming all age III Utah chubs were immature (John 1959). Only 15 percent of the Utah chubs examined in Two Ocean Lake were mature by age IV, 75 percent were mature at age V, and all fish examined were mature by age VI (John 1959).

Fecundity

In fecundity work by Graham (1955) in Hebgen Lake, Montana, and Olson (1959) in Scofield Reservoir, Utah, Utah chubs averaged 40750 and 25282 eggs per female respectively.

Varley and Livesay (1976) reported that female chubs in Flaming Gorge Reservoir averaged 4911 eggs at age III, 15600 eggs at age IV, and 83800 eggs at age V. Varley and Livesay (1976) also felt that following introduction, expanding populations demonstrate substantially increased fecundity over well established populations.

Spawning

Mature spawners begin to congregate in littoral and eulittoral waters when water temperatures approach 12-16°C (John 1963, Graham 1961, Gaufin 1964). Graham (1961) reported spawning activity as early as mid May, and as late as mid August in Hebgen Lake. Most authors agreed that preferred spawning habitat consisted of a zone of vegetation or cover in the eulittoral zone, over a silt, mud, or sand

substrate (Varley and Livesay 1976, Olson 1959, John 1959, Graham 1961). Spawning usually occurred in areas with a gradual slope and some protection from wind and wave action. Cover appears to be the key element of spawning habitat; several authors reported that areas with all features except cover were not utilized for spawning.

Ripe spawners move into spawning areas during early evening and school just off the shoreline (Varley et al. 1976). Single females accompanied by two to three males broadcast eggs in 300-1200 mm of water (Sigler and Miller 1963). This process can continue for a period of several weeks until a female has completed spawning (John 1959, Graham 1954). The non-adhesive eggs are spread at random above the substrate and sink to the bottom (Graham 1954). Eggs hatch in 9 days at 18.2°C and in 6 days at 19.6°C under laboratory conditions (John 1959).

Age and Growth

Age and growth work is done using scales. Scales first form along the lateral line at 20-21.5 mm standard length, and form annuli from October to March (Carbine 1936). Growth is usually computed assuming direct proportion between body and scale growth, and correction factors are occasionally used (Carlander 1969, Neuhold 1957). McConnell et al. (1957) felt that variations in growth rates at different locations were due primarily to density dependent factors rather than

climatological or other factors. This idea is shared by several authors.

Table 1, taken from Carlander (1969) and Varley et. al. (1976) compares calculated total lengths at each annulus for several locations. As with most fish, Utah chub growth rates appear somewhat faster for new and expanding populations. In general adult total lengths range from 203 to 254 mm (Baxter and Simon 1970). The largest Utah chub reported was 560 mm long, weighed 1360 g, and was collected in Bear Lake, Utah (Sigler and Miller 1963). Growth rates in lakes where the Utah chub is endemic appear to be slower than growth rates in lakes and reservoirs where this fish has been introduced (Varley and Livesay 1976).

Diet

Quite versatile, the Utah chub is an omnivorous feeder. Utilizing primarily zooplankton when young, this fish converts to a variety of insects, planktonic organisms and filamentous green algae when older (Sigler and Miller 1963, Baxter and Simon 1970, Brown 1971). Varley and Livesay (1976) observed that Daphnia and copepods predominated in stomach samples (by volume) followed by Spirogyra. Phytoplankton and the filamentous algae (Cladophora and Spirogyra) were the dominant fall food items. Gaufin (1964), and Olson (1959) both observed similar patterns. Fish or fish eggs were not consumed in significant amounts in any of the studies reviewed.

Table 1. Utah chub growth (calculated total lengths) in selected lakes and reservoirs. Table compiled from Carlander (1969) and Varley et. al. (1976).

<u>LOCATION</u>	<u>CALCULATED TOTAL LENGTH AT EACH ANNULUS</u>									
	No.	1	2	3	4	5	6	7	8	9
Fish Lake, Utah (Hazard, 1935)	26	33	89	140	168	188				
Bear Lake, Utah (McConnell et. al. 1957)	206	56	99	147	188	224	254	277	302	356
Hebgen Lake, Montana (Peters, 1964; and Graham, 1961)	475	41	89	155	208	246	277	315	345	
<u>Increment of Growth:</u>		41	48	66	53	36	25	23	20	
<u>Number:</u>		475	437	435	382	329	227	38	4	
Flaming Gorge Reservoir, Wyoming (Varley and Livesay, 1976)		82	127	162	200	242	273			
<u>Increment of Growth:</u>		82	45	35	38	42	31			

Mortality

Mortality increases rapidly at maturity for both sexes although is usually higher for males. Varley and Livesay (1976) stated that in Flaming Gorge Reservoir, female Utah chubs outnumbered males 10 to 1 in age groups five and older. John (1959) and Graham (1969) noted that males seldom survive beyond age 6 and females older than 7 are very rare.

Disease

Most diseases found in Utah chub populations are enzootic and usually occur only under stress conditions when host resistance is low. Widespread mortality among spawners is usually attributed to two species of myxobacteria exhibiting characteristics similar to peduncle disease and columnaris (Varley et. al. 1976). The fungus Saprolegnia, and a flagellated protozoan, Costia have also been reported in Flaming Gorge Reservoir.

John (1959) noted several nematodes and parasites including a larval tapeworm (species not reported) which occurred in 1 percent of the Utah chub population in Two Ocean Lake, Wyoming. The eye fluke, Diplostomum spathaceum, has been documented in several Utah populations (Evans et. al. 1976, Palmieri 1976 and 1977).

DESCRIPTION OF STUDY AREA

The study area was located in the State of Montana on the Madison River and upper Missouri River between Hebgen

Lake and Morony Dam at Great Falls. At Three Forks in Gallatin County, the Madison, Jefferson, and Gallatin Rivers come together to form the Missouri River. Figure 1 shows the general area selected for study. The primary areas sampled were Canyon Ferry Reservoir, Hauser Lake, Lake Helena, Holter Lake, and major slough areas on the Madison, lower Jefferson and Missouri Rivers. Limited sampling was done on Hebgen and Ennis Lakes. Figure 2 identifies the study area in detail.

Hebgen Lake

Hebgen Lake in Gallatin County is an impoundment on the Madison River 29 km northwest of West Yellowstone. The reservoir, formed by an earthfill-concrete core dam, was completed in 1915. A severe earthquake August 7, 1959 lowered the dam 2.97 m and changed the reservoir basin somewhat. The dam was repaired in 1960 to its present condition. Popular for recreation, the reservoir is operated by Montana Power Company for hydroelectric storage. At spillway elevation of 1995 m the reservoir stores about 465 hm^3 of water (usable capacity) over a surface area of 5544 ha. Graham (1961) noted a maximum recorded surface temperature of 24°C , and a maximum depth of approximately 19 m.

Much of the reservoir is shallow. The Grayling Arm has a depth of less than 4.6 m in most places and is usually dry through late fall and winter. Substrate in the Grayling Arm is largely muck, although areas along the southern shore-

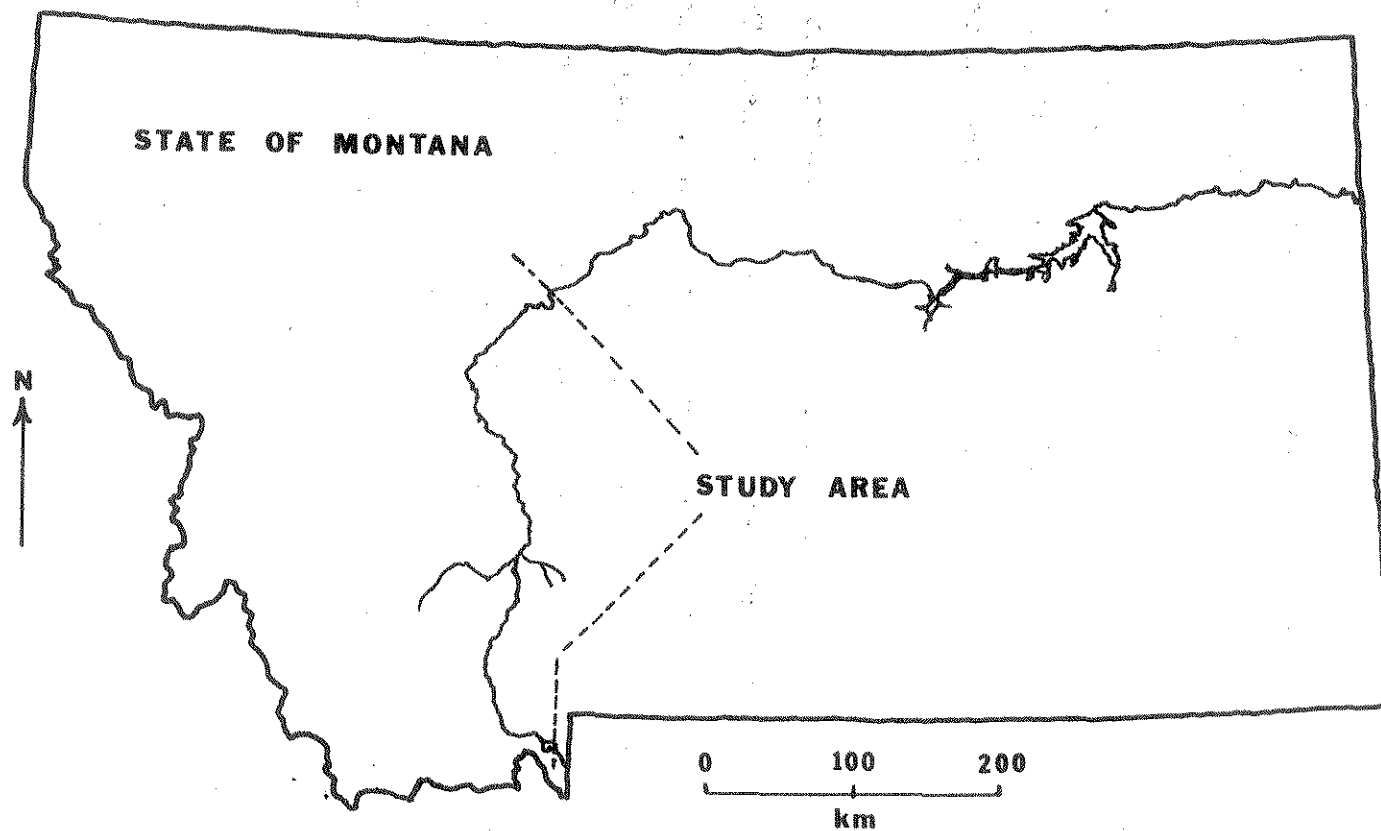


FIGURE 1. Map showing the location of the study area in Montana on the upper Missouri River system.

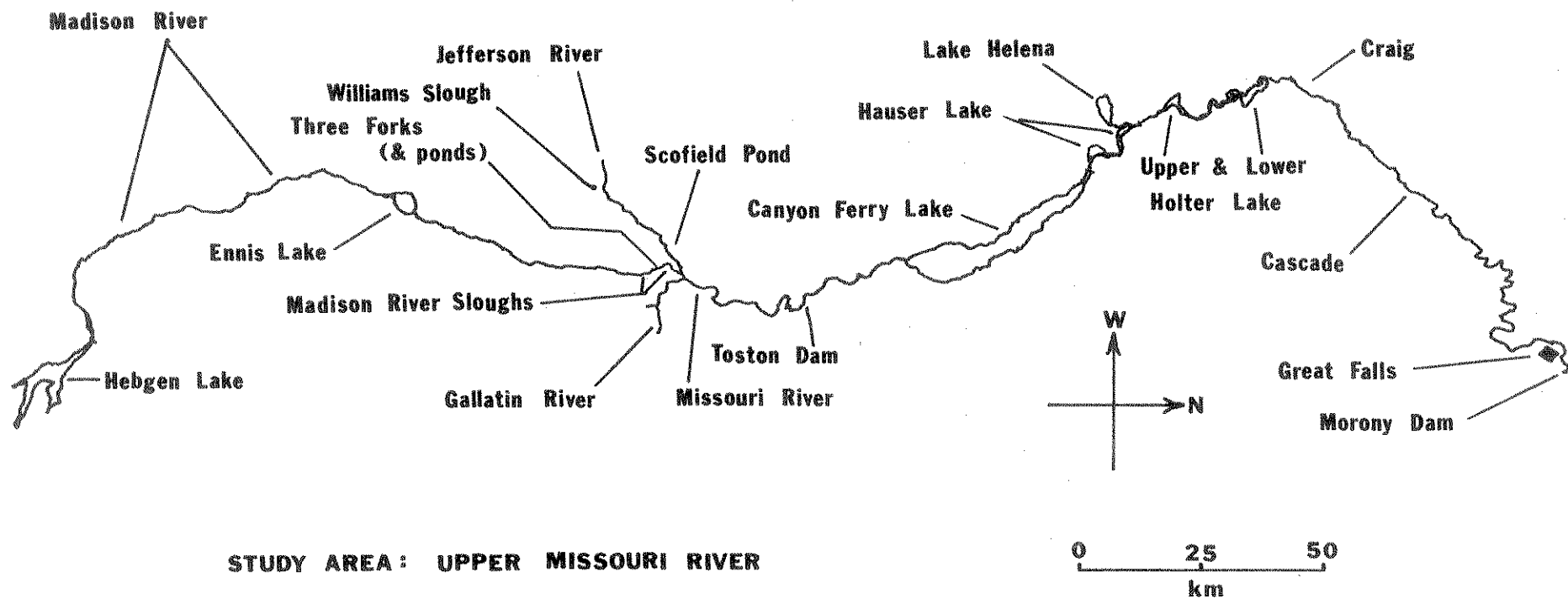


FIGURE 2. Map showing geographical locations in the study area on the Jefferson, Madison, Gallatin, and upper Missouri Rivers.

line consist of sand and gravel. Rooted aquatic vegetation was abundant throughout the arm in large patches during July 1978, although Graham (1961) reported that vegetation abundance fluctuated wildly from year to year.

Similarly, well over half of the Madison arm is less than 4.6 m deep at spillway elevation. Substrate in this area of the lake is largely sand and gravel. Rooted aquatic vegetation is abundant in the shallow areas.

Basically Hebgen Lake is managed for its rainbow and brown trout fishery, although anglers also enjoy moderate numbers of mountain whitefish and a few arctic grayling. The Utah chub is by far the dominant fish in the lake. Small numbers of longnose sucker, longnose dace, and mottled sculpin are also present.

Ennis Lake

Ennis Lake in Madison County is an impoundment on the Madison River 8 km northeast of McAllister. Ennis Dam, also known as Madison Dam, was completed in 1900 and is operated by Montana Power Company as a hydroelectric storage facility. At the top flashboard elevation of 1476 m, the small saucer shaped reservoir stores 50.6 km^3 of water over an area of 1539 ha.

Ennis Lake is noted for its high water temperatures, shallow depth, and abundant rooted aquatic vegetation. A thermograph placed on the Madison River below Ennis Dam

June 21, 1977 indicated mean water temperatures of 20.3°C for the last 10 days of June, 20.0°C for July, 19.0°C for August, and 14.5°C for September (1977).

The southern half of the lake is generally less than 1 m deep and covered with a thick mat of rooted aquatic vegetation. The northern half of the lake ranges from 1 m to 3.5 m deep over most parts, with the deepest point near the dam being 4.6 m. Rooted aquatic vegetation is very patchy in the northern half and exists primarily along the shallow shore areas. The substrate is basically a sandy gravel composition, but areas where vegetation is thick have accumulated large quantities of silt and detritus.

The Utah chub and white sucker are the dominant species present in the lake. Brown trout, rainbow trout, arctic grayling, mountain whitefish, and longnose sucker are also present.

East Three Forks Pond 10-3-22

East Three Forks Pond is the eastern most pond of three ponds located on the east side of Three Forks in Gallatin county. The 8 ha pond is an old gravel pit filled primarily by groundwater, however some water enters the pond from the nearby Madison River, particularly during high water season.

The depth is less than 3 m deep, and rooted aquatic vegetation is abundant over the gravel substrate. Temperatures typically range from 20.0°C to 24.0°C over the June through August period. The intermittent connection between

the pond and the Madison River gives the pond importance as potential Utah chub habitat.

East Three Forks Pond is dominated by populations of golden shiner, white sucker, and carp. Brown trout, mountain whitefish, longnose sucker, yellow perch, largemouth bass, pumpkinseed, and Utah chub are all present to a lesser degree.

Madison River Sloughs 13.02.83

Madison River Sloughs is a portion of the Madison River in the vicinity of Three Forks and Interstate Highway 80, with well developed backwater and slow areas, pools and eddies. Most of the water is less than 2 m deep and has good cover in the form of emergent and rooted aquatic vegetation, rocks, logs, and various rip-rap.

The sloughs are used by brown trout, yellow perch, largemouth bass, white sucker, golden shiner, and Utah chub. Occasional rainbow trout, mountain whitefish, and longnose sucker can be found.

Scofield Pond 10.03.83

Scofield Pond is a 2 ha backwater area on the Jefferson River near the west side of Three Forks and south of Interstate Highway 80. A side channel of the Jefferson River flows through the pond creating good water turnover and fish access. Rooted aquatic vegetation is abundant over a silted gravel substrate. Water depth reaches 2 m.

Brown trout, yellow perch, white sucker, longnose sucker, stonecat, carp, flathead chub, and Utah chub are found in Scofield Pond along with an occasional rainbow trout, mountain whitefish, and golden shiner. Largemouth bass and black crappie have reportedly also been caught in this area.

Williams Slough 10-9420

Williams Slough is a 4 ha area of flooded depressions and side channels along the Jefferson River 3.5 km west of the town of Willow Creek. The water is seldom deeper than 1.5 m and becomes stagnant in areas where flows are poor. Emergent vegetation and willows dominate the edges of the slough with extensive beds of rooted aquatics growing in the open water areas. The substrate is largely soft muck.

Yellow perch, white sucker, carp, golden shiner, largemouth bass and black crappie are found in the slough.

Toston Dam 17-4922

Toston Dam is located about 7 km southeast of Toston on the mainstem of the Missouri River in Broadwater County, and is an overflow structure used to maintain water level elevation for diversion to irrigation canals. Although the Missouri River is backed up somewhat by Toston Dam, no actual usable storage is created. The structure does function as a barrier to upstream movement of fish.

The habitat in the Toston Dam impoundment is not noticeably different from the Missouri River habitat in the area around Toston Dam. The strong current typical of the river above and below Toston Dam prevails in the impoundment itself and maintains a high rate of water turnover.

A deep 2 to 4 m channel, with scattered large submerged boulders characterizes the lower 2 km of the impoundment. The upstream reaches have shallow areas of deposition and islands.

Some development of rooted aquatic vegetation is present on the downstream side of bars and islands. Temperatures normally reach 22°C in July and August, and the maximum recorded surface temperature was 25.5°C (July 23, 1952).

Strong populations of brown trout, rainbow trout, mountain whitefish, white sucker, longnose sucker, stonecat, and flat-head chub are present in the Toston Dam impoundment along with a few yellow perch and carp.

Canyon Ferry Reservoir 17-8832

Canyon Ferry Reservoir is located on the Missouri River in Lewis and Clark, and Broadwater Counties; the dam being 24.0 km east of Helena and the headwaters entering the reservoir about 2 km northeast of Townsend. The dam was completed in 1953 and stores water for flood control, irrigation, power generation, and recreation. Water storage in Canyon Ferry Reservoir submerged the old Lake Sewell, a Montana Power Company reservoir.

The reservoir is about 40.0 km long and holds nearly 2530 hm³ of water over an area of 14245 ha at maximum capacity (1158 m elevation). A broad, flat, basin holds the southern half of Canyon Ferry Reservoir and is about 8.0 km wide. The northern half of the reservoir is more confined by steep hills and has widths ranging from 1.5 to 3.0 km. The maximum depth is 50.3 m.

Mean monthly water temperatures at the generator outlets below the dam for May, June, July, August, and September (1977) were respectively: 7.0°C, 9.5°C, 11.0°C, 13.0°C and 14.5°C. Surface water temperatures at the dam typically range about 5.8°C higher than the outlet temperatures over the same time period. Shallow areas and bays in the upper end of the reservoir warm to 20.0°C through July and August, and exhibit maximum surface temperatures as high as 26.0°C on some days.

The Bureau of Reclamation completed a series of four diked ponds covering about 769 ha at the southern end of the reservoir in 1978. The ponded areas range in depth from 0.5-2.0 m. During July 1978, water depths were 2.0-4.5 m over the southern 1/5 of the reservoir.

In general, rooted aquatic vegetation is lacking in most areas of the reservoir, although most bays had some aquatic plant growth in shallow areas.

Management of the diked areas will be aimed at producing diverse stands of emergent and floating vegetation of value to waterfowl. Fluctuating water levels limit extensive rooted aquatic plant development elsewhere.

The substrate in the southern end of the reservoir is largely sandy gravel and reworked soils of volcanic origin. Dredging to remove material subject to wind erosion when the reservoir is low has produced a fairly uniform bottom on the reservoir side of the dikes. Clay and sandstone substrates dominate the mid-reach with areas of finer material around small and largely intermittent stream inlets. Sand and rocky gravel form the substrate at the northern end of Canyon Ferry.

Brown trout, rainbow trout, mountain whitefish, and yellow perch provide the sport fishery for Canyon Ferry Reservoir. White sucker, longnose sucker, carp, flathead chub, and Utah chub are also found. Other fish reported from the reservoir include mountain sucker, golden shiner, longnose dace, burbot, bluegill, largemouth bass and mottled sculpin. Kokanee fry were stocked in 1966-1968 but few adults were ever reported, and no returns from plants of channel catfish made in 1964 and 1966 have been reported.

Hauser Lake ✓

Hauser Dam, owned by Montana Power Company, is located 21.0 km northeast of Helena on the Missouri River. Completed in 1907, the dam impounds 121.1 km^3 of water at 1108 m elevation, of which just over half is considered usable for hydro-power generation. The reservoir covers an area of 1538 ha and has a maximum depth of 29 m.

Hauser Lake is approximately 25.3 km long and winds through largely canyon and steep hill areas. The upper basin is in a 2.0 km wide bowl narrowing upstream into a canyon at

Anglers prize the brown trout, rainbow trout, and wall-eye in Holter Lake. Whitefish, yellow perch, white sucker, longnose sucker, and carp are also found.

Missouri River Near Craig

The Missouri River between Wolf Creek and Craig has several areas of well developed backwaters and deep pools. Substrates are largely gravel and rubble with scattered large boulders. Silt and muck predominate in the backwaters. Rooted aquatic plant growth is negligible through this area of river. Fishes sampled commonly included brown trout, rainbow trout, mountain whitefish, burbot, white sucker, and longnose sucker.

Tintinger Slough

Tintinger Slough is a 10.0 ha slough 6 km south of Cascade along the Missouri River. Connections between the slough and river are intermittent and probably occur only in springtime during highwater. Maximum depth in the slough is 1.5 m. Rooted aquatic vegetation is abundant over the sand-gravel substrate and emergent vegetation crowds the edges. Water temperatures approach 27.0°C during July and August. Yellow perch, black bullhead, white sucker, longnose sucker, and carp reside in Tintinger Slough.

Reservoir System at Great Falls

Five small dams were constructed on the Missouri River at Great Falls by Montana Power Company for power generation.

The dams simply increase pressure head and do not store significant volumes of water, although approximately 29 km of river is effected by the system. Progressing downstream, the dams are named: Black Eagle, Rainbow, Cochrane, Ryan, and Morony.

Black Eagle Dam was completed in 1890, redeveloped in 1927, and has a volume of 2.1 hm^3 . The deepest point in Black Eagle is 4.5 m. Rainbow Dam was completed in 1910 and impounds 1.3 hm^3 of water. The maximum depth in Rainbow is 6.7 m. Cochrane Dam, the newest of the five dams was completed in 1957, has a volume of 3.3 hm^3 , and a maximum depth of 25.0 m. Ryan Dam, completed in 1915, impounds 2.8 hm^3 of water, and has a maximum depth of about 17.5 m. Morony Dam, completed in 1930, holds about 16.3 hm^3 of water and has a surface area of 121.4 ha. The maximum depth of Morony is 22.6 m.

Black Eagle and Rainbow are similar, being shallow and heavily silted. Cochrane, Ryan, and Morony are deeper, have sandy mud and rock substrates, and are located in a relatively steep walled canyon area. Rooted aquatic vegetation is limited throughout the reservoir system. During July and August, surface water temperatures are about 20.0°C .

Fish most commonly sampled in the reservoir system at Great Falls include: brown trout, rainbow trout, mountain whitefish, walleye, yellow perch, stonecat, black bullhead, white sucker, longnose sucker, and carp.

the tailwaters of Canyon Ferry Dam. The lower half of the reservoir is basically confined in a steep canyon, with open areas to the east along a dredged area called the Eldorado Bar, and on the west along Prickly Pear Creek. Prickly Pear Creek joins Hauser Lake with Lake Helena through an open channel outlet works on Lake Helena. The control works was constructed in 1945 to separate and allow independent regulation of the two reservoirs.

Hauser Lake is used primarily for power generation and recreation. Limited dredging of areas in the reservoir has been done by sapphire mining interests but is currently confined to the tailwaters of Canyon Ferry Dam. Mean surface water temperatures for June, July, August, and September usually range around 21.0°C , 22.0°C , 20.0°C and 15.5°C respectively.

Fish found in Hauser Lake include: brown trout, rainbow trout, whitefish, yellow perch, white sucker, longnose sucker, carp, flathead chub, and Utah chub.

Lake Helena ✓

Lake Helena is located 21 km northeast of Helena on Prickly Pear Creek in Lewis and Clark County. Originally regulated by Hauser Lake, the control works constructed in 1945 currently allows independent regulation of the two reservoirs. Approximately 12.9 km^3 of water can be stored in the 850 ha lake at maximum elevation of 1108 m. The deepest point near the dam, is 3 m, however most of the reservoir is less than 2 m deep. Water is used for power production by Montana Power.

Lake Helena is characterized by its shallow warm water, and abundant rooted aquatic vegetation over a sandy-mud substrate. Surface temperatures frequently reach 25.0°C during July and August.

Lake Helena hosts fine rainbow trout and yellow perch populations, along with brown trout. Fishermen have reported catching occasional walleye. White sucker, longnose sucker, carp, and Utah chub are also present.

Holter Lake ✓

Holter Lake Dam is located in Lewis and Clark County 5.3 km east of Wolf Creek (town). The dam, completed in 1918 impounds 296.5 hm³ of water over 1942.5 ha, at an elevation of 1086 m. The deepest point in the reservoir is approximately 25 m. Owned by Montana Power Company, the reservoir is used for power generation and recreation.

Holter Lake lies in two basins separated by nearly 37 km of canyon area. Upper Holter Lake has extensive areas of gravel-cobble substrate along shallow (2.5 m) bench like areas, while large rocks and steep cliffs dominate the canyon area substrate. Sandy-mud substrates predominate in Lower Holter Lake. Rooted aquatic vegetation is conspicuously absent throughout most of the reservoir, however, submerged brush and trees are present in many areas. Surface temperatures approach 21.0°C during July and August.

Methods

Fish were collected using 38.1 X 1.8 m experimental gill nets, with mesh sizes graduated in 5 panels from 19.1 mm (stretched mesh) to 50.8 mm. Nets were generally set in the afternoon, fished overnight and picked the following morning. Eulittoral and littoral net sets were placed perpendicular to the shore line at depths ranging from 6 m to the surface. Additional sampling was done in the pelagic areas of reservoirs using surface net sets.

Selected Utah chub specimens collected during the progress of the study were deposited in the Zoology and Entomology Department, Montana State University, Bozeman, Montana. Field work was done May through September 1978. The locations of gill net sets in major reservoirs are recorded on maps in Appendices B through F.

RESULTS

The Utah chub has expanded its range in the upper Missouri River system since first being observed in Hebgen Lake around 1935. At present this fish has dispersed the distance from Hebgen Dam to Hauser Dam; a distance of 312.7 river km.

Previous investigations by the Montana Fish and Game Department demonstrated the occurrence of Utah chub through the full length of the Madison River below Hebgen Lake by 1961

(Graham 1961). Utah chubs were reported from gill net samples in Canyon Ferry Reservoir during 1967 and 1968 (Bandow 1969). In October of 1970 a single Utah chub was collected from Hauser Lake by Montana Fish and Game Department investigators (Holton 1978).

This study confirmed the existence of Utah chubs in Canyon Ferry Reservoir and Hauser Lake. No Utah chubs were sampled below Hauser Dam through the upper Missouri River system to Morony Dam at Great Falls. Figure 3 shows sites where Utah chubs were collected previous to and during this study.

Knowing well established populations of Utah chub existed in Hebgen and Ennis Lakes, sampling efforts were concentrated downstream between Ennis Dam and Morony Dam. Gill net hours logged on Hebgen and Ennis Lakes totaled only 80.0, compared to 2157.3 gill net hours logged downstream from Ennis Dam. Table 2 summarizes catch numbers and rates, percents of sample, lengths, and weights of Utah chubs by sample area.

Appendix 6 shows the data of Table 2 in English units of measurements. Appendices H through V summarize gill net sets by sample area for all species collected.

Catch rates indicated that the Utah chub populations in Canyon Ferry Reservoir, Hauser Lake and Lake Helena were poorly developed. A total of 486.54, 415.58 and 166.83 hours gill net effort were used respectively for the three reservoirs. The sample from Canyon Ferry Reservoir (exclusive of the

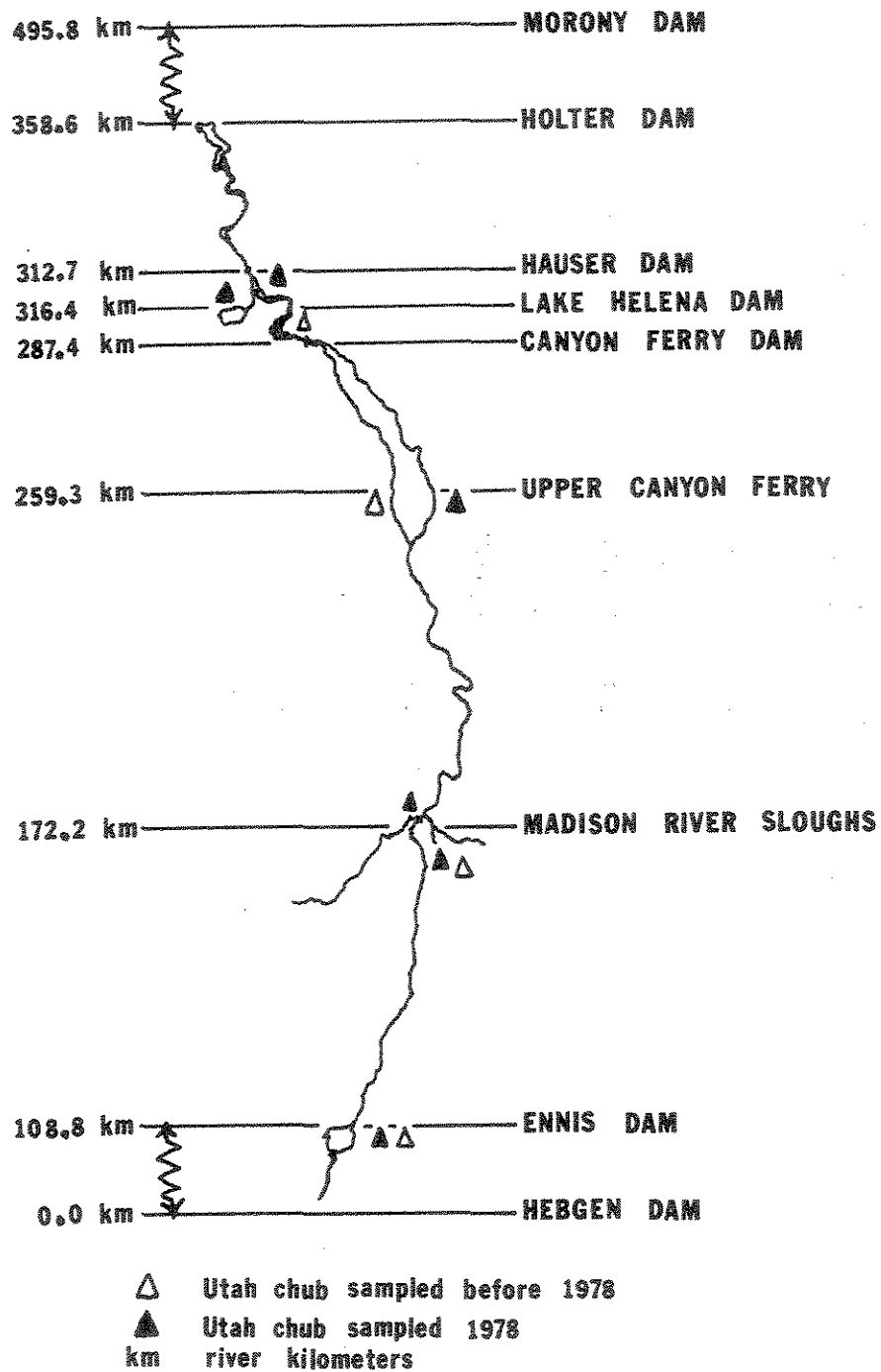


FIGURE 3. Map showing distances downstream from Hebgen Dam, and sites where Utah chubs were collected during and previous to 1978.

Table 2. Utah chub catch numbers and rates, percents of sample, lengths, and weights by sample area.

Location	Date Sampled	Number Sampled	% Total Catch	Catch Rate per hour	Mean Length (mm)	Range (mm)	Mean Weight (g)	
Hebgen Lake	7/78	319	87.2	4.833	269	165-345	272	
Ennis Lake	7/78	39	38.2	2.786	-	-	-	
Scofield Pond	6/78	1	2.9	0.022	307	-	349	
East Three Forks Pond	8/78	7	3.0	0.099	206	163-249	127	
Madison River Sloughs	6/78	6	7.7	1.107	147	140-155	36	20
Canyon Ferry Waterfowl Ponds	7/78	3	0.8	0.054	201	180-236	122	
Canyon Ferry Reservoir	7/78	19	0.9	0.039	208	157-272	136	
Hauser Lake	7/78	1	0.05	0.002	231	-	159	
Lake Helena	7/78	1	0.1	0.006	363	-	494	

waterfowl ponds) contained 19 Utah chubs while the sampled from Hauser Lake and Lake Helena each contained only 1 Utah chub. Utah chubs comprised less than 1 percent of the samples from all three reservoirs.

The rate of dispersal or downstream migration for the Utah chub was calculated as the distance moved downstream from Hebgen Dam per unit time since 1935. Dispersion calculations were done using the chub collections made for this investigation, and for chubs collected by investigators on the upper Missouri River system previous to this study. Table 3 shows distances, sample dates and calculated dispersal rates for the study area. Appendix W contains the data of Table 3 in English units of measurements.

Dispersal rates to Canyon Ferry and Hauser Dams were 6.7 and 7.3 km/year respectively when calculated using the data of this study. Using the 1967 data of Badow (1969) and the 1970 data of Nevala (Holton 1978), dispersal rates to Canyon Ferry and Hauser Dams were 9.0 and 8.9 km/year respectively. Canyon Ferry Dam is approximately 287.4 km from Hebgen Dam while Hauser Dam is about 312.7 km downstream from Hebgen Dam.

Several features of preferred Utah chub habitat became apparent as the study progressed. Adult Utah chubs sampled were usually captured in areas where rooted aquatic plants were absent. If rooted aquatic vegetation was abundant in a reservoir, for example Ennis Lake, the bulk of the chubs sampled were captured in areas of the reservoir lacking dense rooted aquatics.

Table 3. River kilometers and rate of downstream dispersal for Utah chub from Hebgen Dam. Utah chubs first observed at Hebgen Lake in 1935.

	Distance from Hebgen Dam River/km	RATE OF MOVEMENT	
		Utah chubs sampled 1978 km/yr	Utah chubs sampled before 1978 km/yr
Ennis Lake	108.8	-	-
Madison River Sloughs	172.2	-	6.6*
Canyon Ferry (northernmost capture)	259.3	6.0	8.1**
Canyon Ferry Dam	287.4	6.7	9.0***
Hauser Lake (opposite Spokane Creek)	295.0	-	8.4***
Hauser Lake (site of 1978 capture)	305.5	7.1	-
Hauser Dam	312.7	7.3	8.9***
Lake Helena Dam	316.4	7.4	9.0***
Holter Lake Dam	358.6	-	-
Morony Dam	495.8	-	-

*calculated from Graham's 1961 observations (Graham 1961)

**calculated from Bandow's 1967 observations (Bandow 1969)

***calculated from Nevala's 1970 observation (Holton 1978)

All Utah chubs sampled were netted in water less than 3 m deep (littoral areas). This phenomenon could reflect spawning behavior since collections were made primarily during June, July and August. Catch rates for Utah chub sampled in floating surface nets were nearly identical to chub catch rates in bottom net sets, being 1.26 chubs/hour and 1.16 chubs/hour respectively (for all chubs netted).

Substrates where Utah chubs were captured general had a rocky gravel or sandy gravel composition. Large rocks and boulders were often present. In addition the substrates in Canyon Ferry Reservoir and Hauser Lake where Utah chubs were sampled had both been recently dredged. Utah chubs were scattered across the entire dredged area of Canyon Ferry Reservoir associated with the Bureau of Reclamation's dust abatement project. Chubs were not found in any other part of the reservoir. The chub sampled in Hauser Lake was collected from an area near the Eldorado Bar which had been dredged for sapphires.

DISCUSSION

Confirmation of Utah chubs living in Hauser Lake, but no further downstream is the most significant finding in this study related to present chub distribution in the upper Missouri River. Two points about this finding are important. The Utah chub sampled in 1970 at Hauser Lake (Holton 1978) was not positively identified as a Utah chub by the investigator, and was not retained as a museum specimen for future identification.

Secondly, only 1 Utah chub was collected at Hauser Lake in 414.96 hours of gill net effort. The sampling effort in Hauser Lake indicates the Utah chub has been unable to develop sufficient numbers at this time to be readily detectable. An 8 year period has elapsed since the previous chub collection in Hauser was made and no apparent changes in the status of the Utah chub population have occurred. Stating that no change in the Utah chub population has occurred assumes that the original 1970 chub collection in Hauser was in fact a Utah chub. This same assumption was made when calculating downstream dispersal rates, and will be discussed with respect to dispersal at a later point.

A single Utah chub was also collected (after 167.04 gill net hours of effort) in Lake Helena, which is directly connected with the Prickly Pear arm of Hauser Lake via the outlet structure on the Lake Helena Dam. No barriers to fish movement exist between the two reservoirs. Commercial fishermen working Lake Helena had neither heard reports of, nor observed any Utah chubs through this report date (Grasteit 1978). If the Utah chub population in Hauser Lake develops into a reproducing population, Lake Helena could become a major spawning area. The firm sandy-mud substrate, warm water temperatures, abundant rooted aquatic vegetation, and shallow depths characteristic of Lake Helena provide good Utah chub spawning and nursery habitat.

time, possibly years, after they arrived. Dispersal rate estimates were made using both the dates of observation from this study, and the observations of Badow (1969) and Nevala (Holton 1978). Estimates of dispersal rate based on the observations of Badow in Canyon Ferry Reservoir (Utah chubs collected in 1967) and Nevala in Hauser Lake are similar, being 9.0 and 8.9 km/year. These rates were calculated based on the distance from Hebgen Dam to the respective reservoir dams. The similarity of the two estimates provide circumstantial evidence that the 1970 chub observation in Hauser Lake was in fact a Utah chub; and that the Utah chub populations were sampled in Canyon Ferry and Hauser at about the same point in their development. The estimates on dispersal rate for this study may be somewhat conservative in view of the 1967 and 1970 Utah chub samples.

Projection of the rate of downstream movement for chubs below Canyon Ferry Reservoir based on the rate estimates in this report should be done with extreme caution. It is not known why the Utah chub has been unable to develop into a significant component of the fish population in Canyon Ferry since it was first sampled there 11 years ago. In addition, the river and reservoirs below Canyon Ferry differ markedly in habitat and fish populations from the river and reservoirs above Canyon Ferry.

Netting in sloughs and backwaters on the Madison and Jefferson Rivers document the use of these areas by the Utah

chub. Populations are well developed in the Madison River Sloughs with these fish comprising 7.7 percent of the samples taken (catch rate - 1.1 Utah chub/hour). The lower Jefferson River Utah chub population is relatively weak at this point comprising 2.9 percent of the Jefferson samples (catch rate = 0.022 Utah chub/hour). It is not known if these populations are resident or transient.

Occurrence of the Utah chub in the Jefferson River (Scofield Pond) is consistent with Graham's (1954) finding at Hebgen Lake demonstrating that chubs move at least short distances up streams and tributaries. No Utah chubs were sampled in areas similar to and including Toston Reservoir, where the Missouri River maintains a strong current and high turnover rate.

SUMMARY

(1) The Utah chub has expanded its range in the upper Missouri River system since it was first observed in Hebgen Lake around 1935.

(2) In this investigation a single Utah chub was sampled in Hauser Lake, and it was found near the Eldorado Bar after 17.29 gill net days effort.

(3) In this investigation a single Utah chub was collected in Lake Helena after 6.96 gill net days effort. Lake Helena is directly connected (no barriers to movement) with Hauser Lake.

(4) The Utah chub may have appeared in Hauser Lake as early as October 1970 when one was reportedly gill netted in a shallow area opposite Spokane Creek.

(5) No Utah chubs were sampled below Hauser Lake Dam, after extensive sampling effort in 1978.

(6) Since the Utah chub was introduced at Hebgen Lake in 1935, it traveled the 312.7 river km from Hebgen Dam to Hauser Dam, and was first noticed in Hauser Lake 35 to 43 years later. This yields a dispersal rate ranging from 8.9 to 7.3 km/year.

(7) The small Utah chub population in Canyon Ferry Reservoir is restricted to a shallow area at the southern end of the reservoir which had been recently dredged.

(8) The sampling effort in Hauser Lake indicated the Utah chub has been unable to develop sufficient numbers at this time to be readily detectable.

(9) Although probably using rooted aquatic vegetation for cover and nursery areas, all Utah chubs sampled in this study were netted in areas of reservoirs and sloughs where rooted aquatic vegetation was least developed.

(10) Utah chubs will use slough and backwater areas of rivers and streams but apparently will not reside in areas like Toston Reservoir where a relatively strong current and high turnover rate is maintained.

RECOMMENDATIONS

The following are recommendations related to Utah chub distribution in the upper Missouri River:

(1) The Utah chub population in Canyon Ferry Reservoir should be monitored through routine yearly sampling, to detect any changes in density. Chub population dynamics in Canyon Ferry Reservoir may be an indication of what influence the Utah chub will have on downstream sport and commercial fisheries.

(2) Hauser Lake should be carefully monitored to detect any increases in Utah chub density, which would indicate the chub has established a viable reproductive population in Hauser.

(3) Holter Lake should be regularly sampled to detect the possible downstream movement of the Utah chub. If the Utah chub appears in Holter Lake, museum specimens should be retained, and downstream dispersal rates calculated. The effects of interaction between the walleye population in Holter and the Utah chub should be studied.

In addition the following life history requirements are recommended for future study:

(1) The preferred habitat of the Utah chub for all age classes should be more clearly defined.

(2) Density dependent population regulatory mechanisms for the Utah chub should be studied and related to preferred habitat.

No Utah chubs were collected in 676.8 gill net hours effort downstream from Hauser Lake Dam through the system to Morony Dam. This area includes Holter Lake, the Missouri River to Great Falls, and the reservoir system on the Missouri River through Great Falls. In other fisheries investigations by the Montana Fish and Game Department downstream from Morony Dam through Fort Peck Reservoir, no Utah chubs have been sampled.

A study on the longitudinal distribution, taxonomic composition, and habitat preferences of forage fish in the Missouri River between Morony Dam and Fort Peck Reservoir, failed to locate any Utah chubs in several hundred bag seine and electrofishing samples (Berg 1978). Similarly, no chubs have been observed during recent investigations in Fort Peck Reservoir (Liebelt 1978).

The Utah chub population in Canyon Ferry Reservoir has remained marginal; unable to develop significant densities or distribution within the reservoir during the 11 year period after Bandow first sampled chubs in Canyon Ferry. Utah chubs comprised less than 1 percent of samples taken, both during this study and during Bandow's investigation (Bandow 1969). In July 1978, after extensive gill netting in all areas of the reservoir, and including surface and mid-depth (3-10 m), and pelagic sets, only 22 chubs were sampled.

Three Utah chubs were captured within the diked waterfowl ponds associated with the dust abatement project. The remaining

19 chubs were all captured within the shallow dredged area at the southern end of Canyon Ferry. The southern end is characterized by rather high afternoon surface temperatures (24°C for July), relatively turbid water, a clean sand-gravel substrate, limited rooted aquatic plant development, and a maximum depth of about 4.5 m. Few salmonids were captured in the dredged southern portion of the Reservoir during July, however the yellow perch, white sucker, and flathead chub populations were all strongly represented in the samples.

Some factor or combination of factors is repressing Utah chub dispersal and development in Canyon Ferry. Intense competition for food, and suitable reproductive and nursery habitat with other well established species in the reservoir such as the yellow perch and flathead chub may be important. The yellow perch may also prey heavily on young Utah chub.

Calculated dispersal rates which estimate the rate of migration from Hebgen Dam to points downstream were based on the following assumptions.

- 1) The Utah chub population in Hebgen Lake began moving downstream in 1935 and not before that time.
- 2) Utah chubs sampled for this and previous investigations were descendants of the migrating population which had become established at points downstream from Hebgen Dam, and were not individuals which had recently moved from Hebgen Lake.
- 3) The Utah chub was not present at a downstream location before the year of capture.

Estimates on the rate of downstream dispersal are confused somewhat by the fact that dispersing individuals or populations may not have been observed in a new location for some

(3) Interspecific competition for food and space with other fishes should be studied further.

(4) Predator-prey relationships between the Utah chub and associated species should be studied and quantified.

(5) The commercial uses and potential should be examined and developed.

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APPENDICES (con't.)

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V	Black Eagle, Cochrane, and Morony Res. gill netting summary	65
W	River miles and rate of downstream dispersal for Utah chubs from Hebgen Dam	66

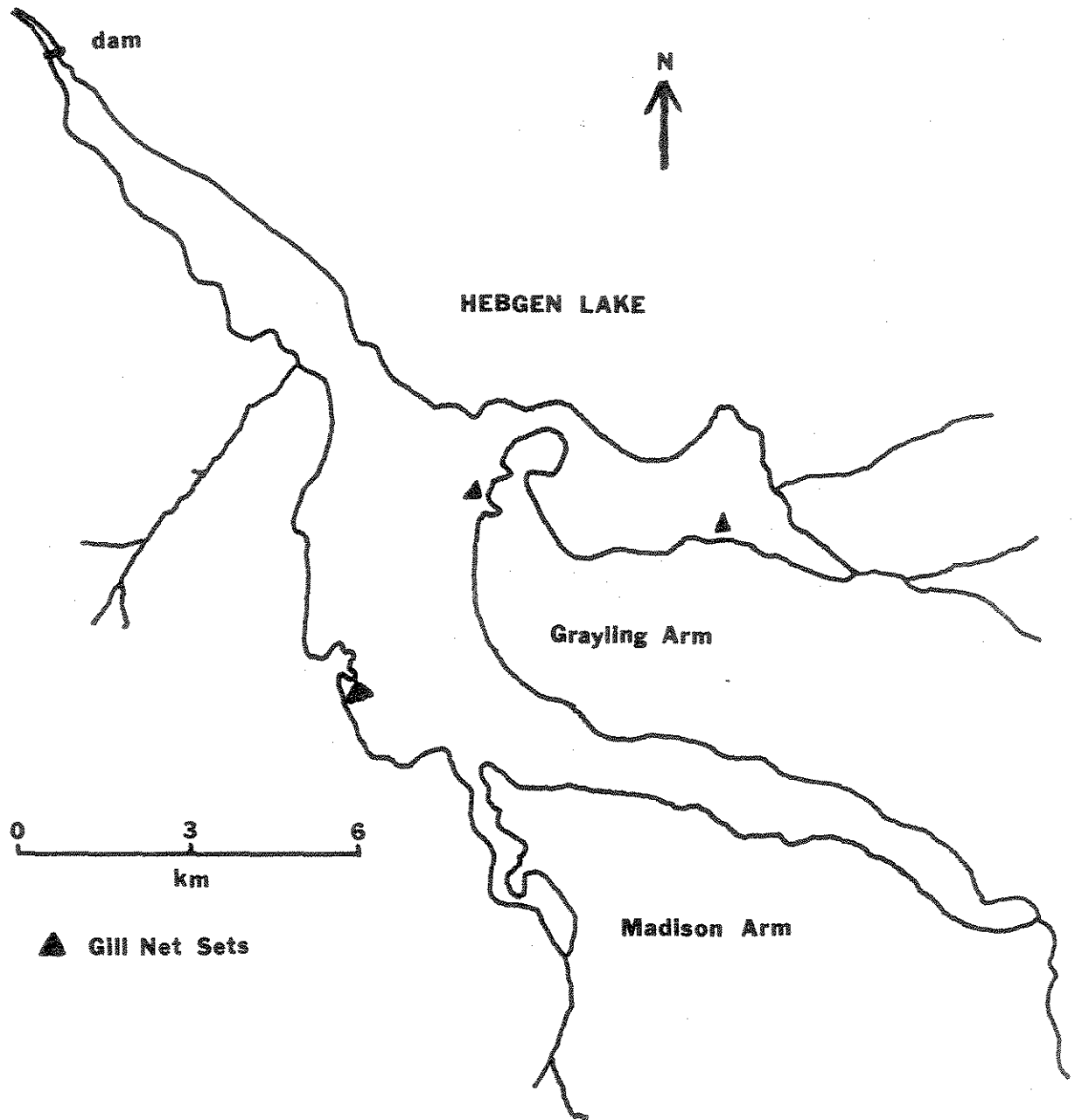
Appendix A. Common and scientific names of fishes mentioned in this paper (American Fisheries Society, 1970. A list of common and scientific names of fishes from the United States and Canada. Special Pub. No. 6, third edition. Reeve M. Bailey, ed. 150 p.)

COMMON NAME	SCIENTIFIC NAME
<u>SALMONIDAE</u>	
Brown trout	<u>Salmo trutta</u> Linnaeus
Rainbow trout	<u>Salmo gairdneri</u> Richardson
Cutthroat trout	<u>Salmo clarki</u> Richardson
Arctic grayling	<u>Thymallus arcticus</u> (Pallas)
Mountain whitefish	<u>Prosopium williamsoni</u> (Girard)
Kokanee	<u>Oncorhynchus nerka</u> (Walbaum)
<u>PERCIDAE</u>	
Walleye	<u>Stizostedion vitreum vitreum</u> (Mitchill)
Yellow perch	<u>Perca flavescens</u> (Mitchill)
<u>CENTRARCHIDAE</u>	
Largemouth bass	<u>Micropterus Salmoides</u> (Lacepede)
Pumpkinseed	<u>Lepomis gibbosus</u> (Linnaeus)
Black crappie	<u>Pomoxis nigromaculatus</u> (Lesueur)
Bluegill	<u>Lepomis macrochirus</u> Rafinesque
<u>GADIDAE</u>	
Burbot	<u>Lota lota</u> (Linnaeus)
<u>ICTALURIDAE</u>	
Stonecat	<u>Noturus flavus</u> Rafinesque
Black bullhead	<u>Ictalurus melas</u> (Rafinesque)
Channel catfish	<u>Ictalurus punctatus</u> (Rafinesque)
<u>CATOSTOMIDAE</u>	
White sucker	<u>Catostomus commersoni</u> (Lacepede)
Longnose sucker	<u>Catostomus catostomus</u> (Forster)
Mountain sucker	<u>Catostomus platyrhynchus</u> (Cope)
<u>CYPRINIDAE</u>	
Carp	<u>Cyprinus carpio</u> Linnaeus
Golden shiner	<u>Notemigonus crysolencas</u> (Mitchill)
Flathead chub	<u>Hybopsis gracilis</u> (Richardson)
Utah chub	<u>Gila atraria</u> (Girard)
Longnose dace	<u>Rhinichthys cataractae</u> Valenciennes)
<u>COTTIDAE</u>	
Mottled sculpin	<u>Cottus bairdi</u> Girard

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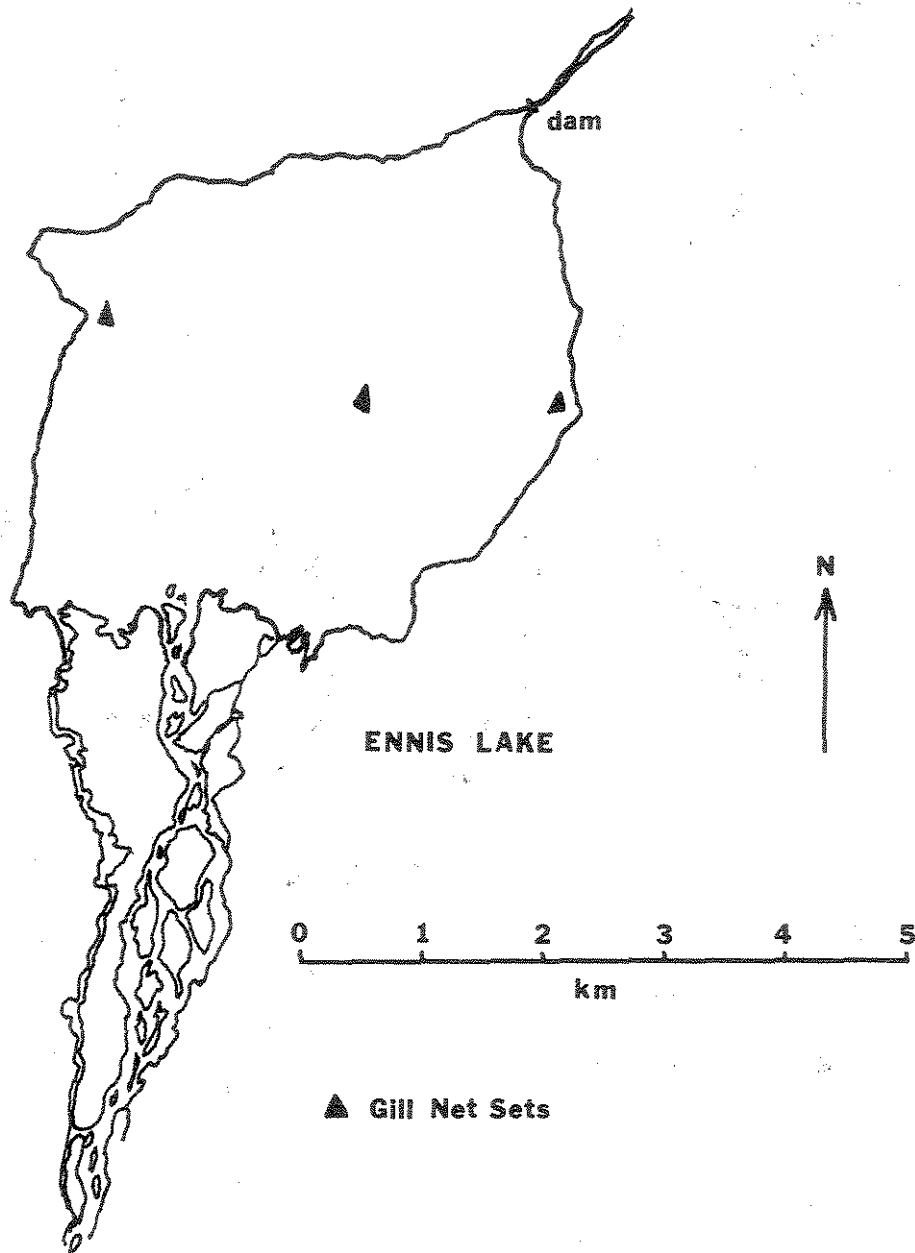
APPENDICES

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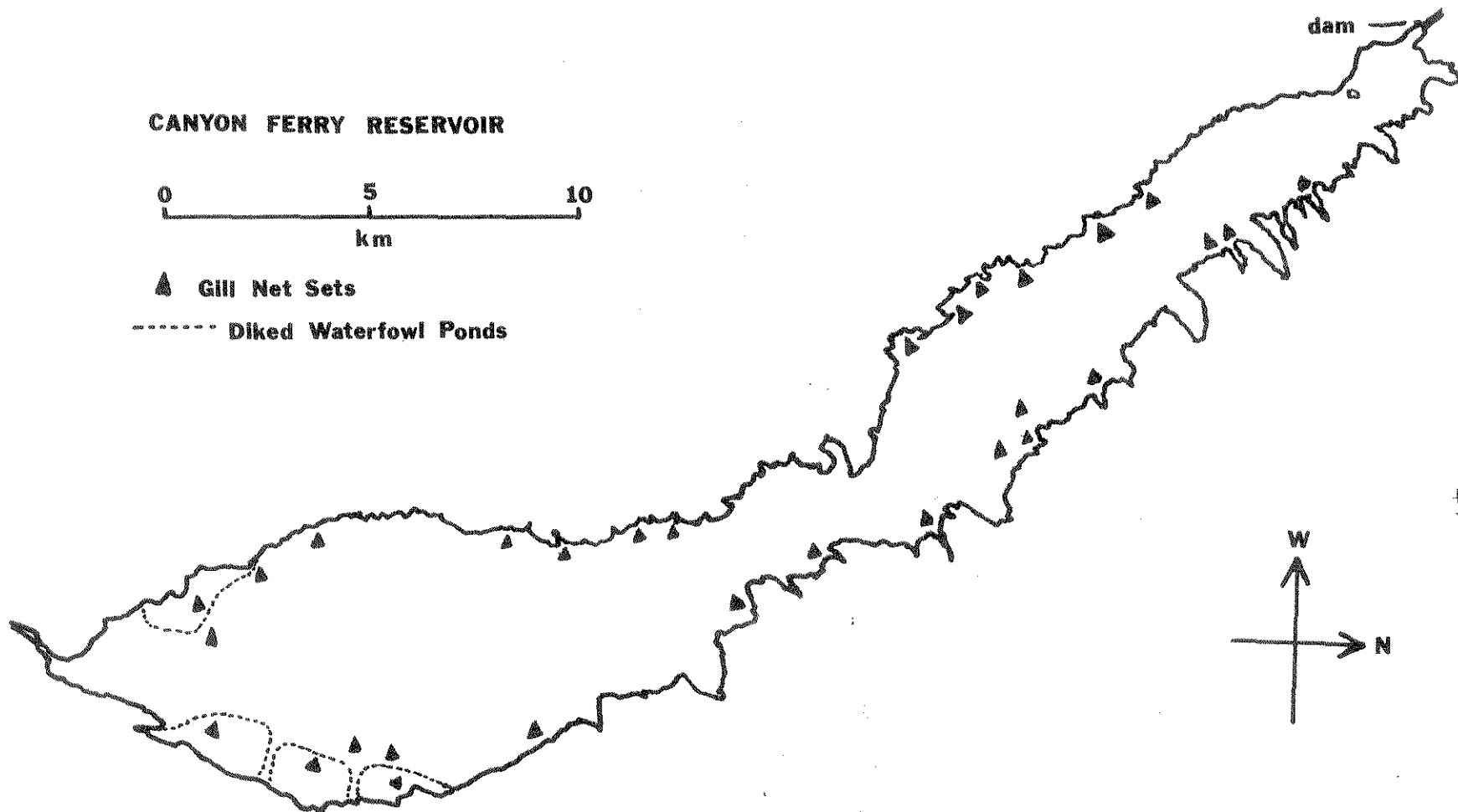


Appendix B. Map of Hebgen Lake showing gill net sets.

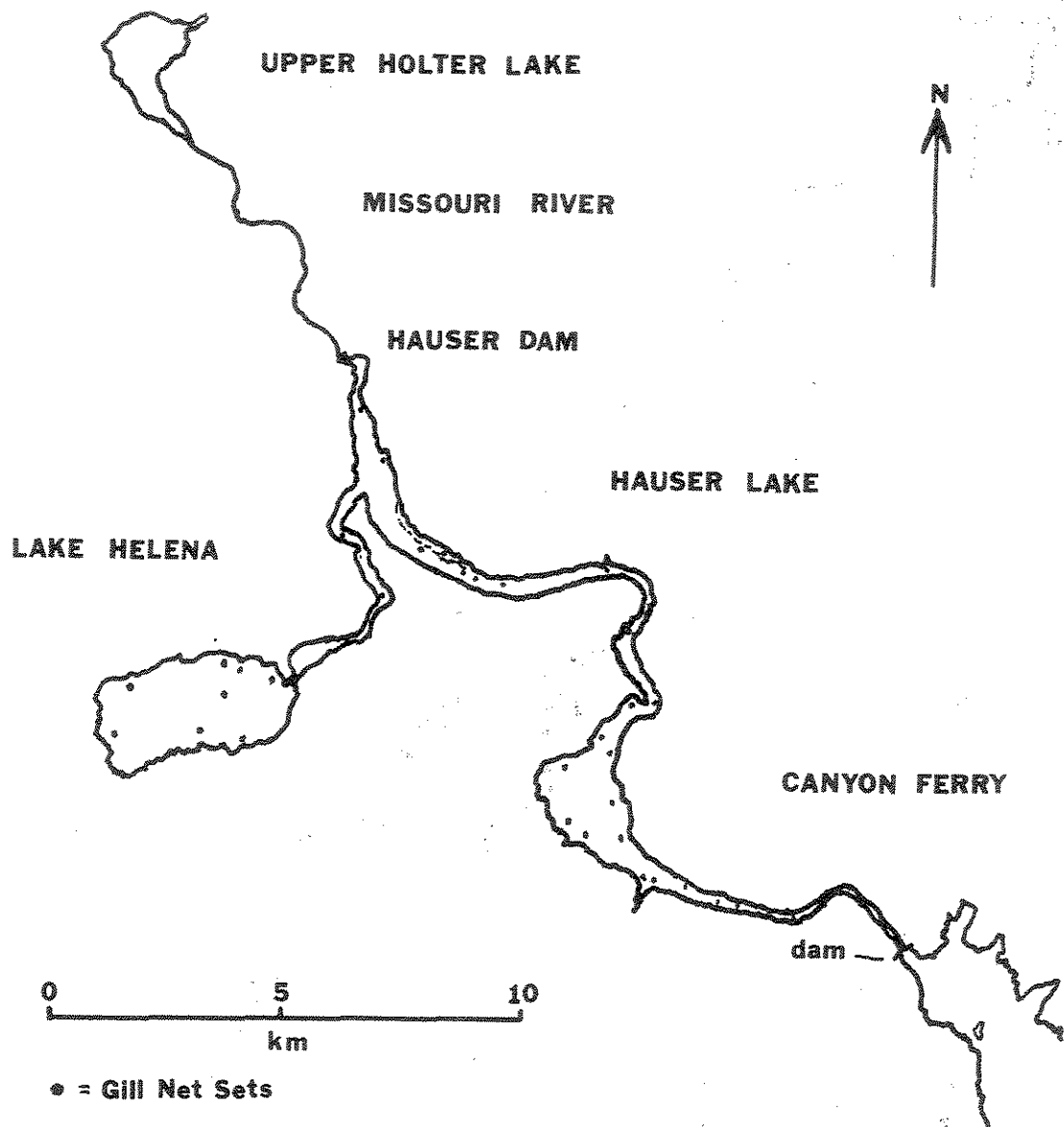
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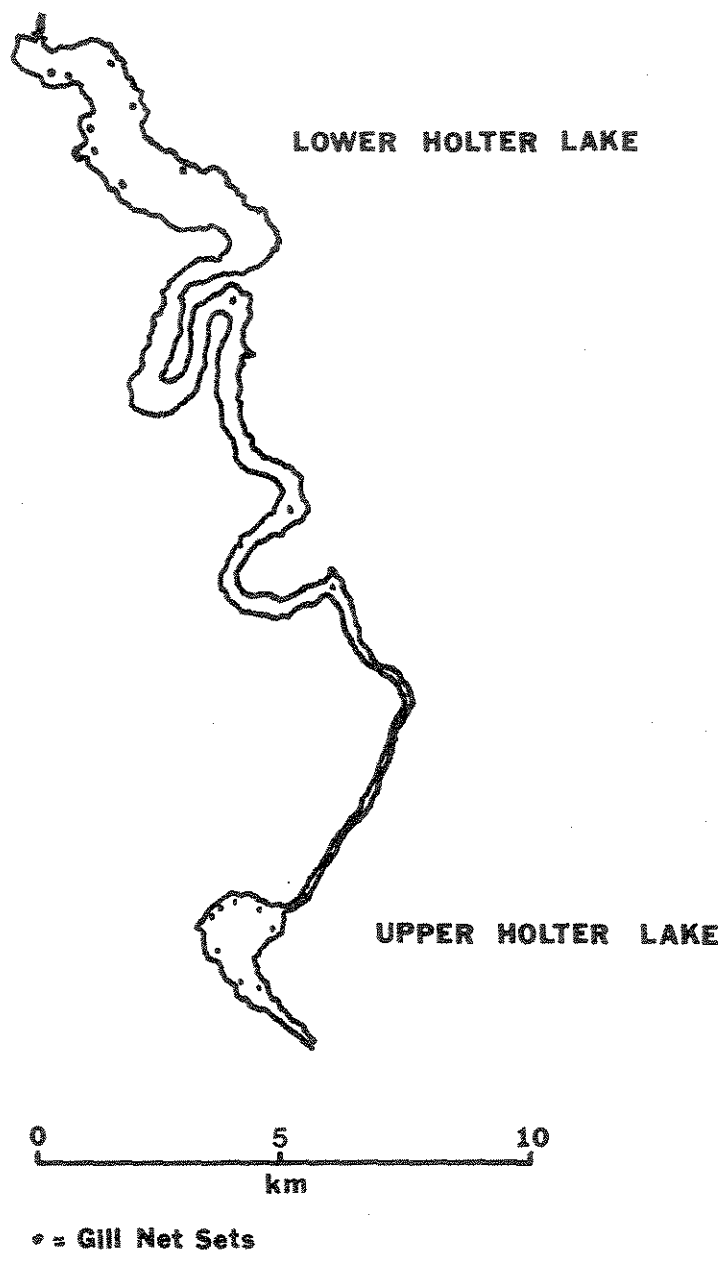
APPENDIX C. Map of Ennis Lake showing gill net sets.



APPENDIX D. Map of Canyon Ferry Reservoir showing gill net sets.



APPENDIX E. Map of Hauser Lake and Lake Helena showing gill net sets.



APPENDIX F. Map of Holter Lake showing gill net sets.

Appendix G. Utah chub catch numbers, percents of sample, lengths, and weights by sample area. English units are used.

LOCATION	DATE SAMPLED	NUMBER SAMPLED	PERCENT TOTAL CATCH	MEAN LENGTH (in.)	RANGE (in.)	MEAN WEIGHT (lb.)
Hebgen Lake	7/78	319	87.2	10.6	6.5-13.6	0.60
Ennis Lake	7/78	39	38.2	-	-	-
Scofield Pond	6/78	1	2.9	12.1*	-	0.77
East Three Forks Pond	8/78	7	3.0	8.1	6.4-9.8	0.28
Madison River Sloughs	6/78	6	7.7	5.8	5.5-6.1	0.08
Canyon Ferry Waterfowl Ponds	7/78	3	0.8	7.9	7.1-9.3	0.27
Canyon Ferry Reservoir	7/78	19	0.9	8.2	6.2-10.7	0.30
Hauser Lake	7/78	1	0.05	9.1*	-	0.35
Lake Helena	7/78	1	0.1	14.3*	-	1.09

*only one Utah chub sampled

Appendix H. Hebgen Lake (Madison River) gill netting summary by species sampled. Net sets made 7/23/78 through 7/24/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)	53
Brown trout	27	0.409	7.4	16.6	7.9-21.7	1.73	3	
Rainbow trout	2	0.030	0.5	11.4	-	0.60	(66.00)	
Mountain whitefish	18	0.273	4.9	15.6	14.3-16.9	1.45		
Utah chub	319	4.833	87.2	10.6	6.5-13.6	0.60		
TOTAL	366	5.545						

Appendix I. Ennis Lake (Madison River) gill netting summary
by species sampled. Nets sets made 7/26/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Net Sets (hours)
White sucker	54	3.857	52.9	3
Longnose sucker	9	0.643	8.8	(14.00)
Utah chub	<u>39</u>	<u>2.786</u>	38.2	
TOTAL	102	7.286		

Appendix J. Williams Slough (Jefferson River near Willow
Creek) gill netting summary by species sampled.
Net sets made 6/22/78 through 6/23/78 and 9/7/78
through 9/8/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Net Sets (hours)
Yellow perch	26	0.341	12.5	4
White sucker	149	1.956	71.6	(76.17)
Carp	15	0.197	7.2	
Golden shiner	11	0.144	5.3	
Largemouth bass	6	0.079	2.9	
Black crappie	<u>1</u>	<u>0.013</u>	0.5	
TOTAL	208	2.731		

Appendix K. Scofield Pond (Jefferson River near Three Forks) gill netting summary by species sampled. Net sets made 6/21/78 through 6/22/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)	
Yellow perch	3	0.065	8.6	7.5	5.9- 9.0	0.23	2	55
White sucker	8	0.172	22.9	9.6	6.8-12.6	0.36	(46.50)	
Longnose sucker	1	0.022	2.9	6.8	-	0.12		
Stonecat	2	0.043	5.7	7.7	6.5- 8.8	0.23		
Carp	3	0.065	8.6	9.9	8.1-12.1	0.58		
Flathead chub	12	0.258	34.3	7.8	6.4- 9.5	0.20		
Utah chub	1	0.022	2.9	12.1	-	0.77		
Brown trout	5	0.108	14.3	13.7	10.9-17.4	0.96		
TOTAL	35	0.753						

Appendix L. East Three Forks Pond (Madison River at Three Forks) gill netting summary by species sampled. Net sets made 8/30/78 through 8/31/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	1	0.014	0.4	21.5	-	3.32	4
Mountain whitefish	1	0.014	0.4	9.8	-	0.30	(70.42)
White sucker	63	0.895	26.8	10.6	7.3-13.8	0.43	
Longnose sucker	3	0.043	1.3	8.1	7.0-9.9	0.18	
Yellow perch	7	0.099	3.0	7.0	5.1-8.7	0.16	
Largemouth bass	1	0.014	0.4	-	-	-	
Pumpkinseed	1	0.014	0.4	-	-	-	
Carp	35	0.497	14.9	10.8	10.1-13.2	0.61	
Golden shiner	116	1.647	49.4	6.6	5.7-7.2	0.15	
Utah chub	7	0.099	3.0	8.1	6.4-9.8	0.28	
TOTAL	235	3.337					

Appendix M. Madison River Sloughs (near Three Forks) gill netting summary by species sampled. Net sets made 6/21/78 through 6/23/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	3	0.554	3.8	15.3	12.6-20.8	1.29	3
Yellow perch	13	2.399	16.7	-	-	-	(5.42)
Largemouth bass	1	0.185	1.3	4.8	-	-	
White sucker	38	7.011	48.7	10.4	6.9-14.4	0.50	
Longnose sucker	1	0.185	1.3	7.4	-	0.13	
Golden shiner	16	2.952	20.5	5.7	5.0- 7.0	0.07	
Utah chub	6	1.107	7.7	5.8	5.5- 6.1	0.08	
TOTAL	78	14.391					

Appendix N. Toston Dam (Missouri River) gill netting summary by species sampled. Net sets made 6/19/78 through 9/7/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	16	0.101	4.7	13.9	8.1-20.5	1.13	8
Rainbow trout	14	0.089	4.1	13.4	6.9-18.1	0.95	(158.17)
Mountain whitefish	10	0.063	3.0	10.2	6.9-13.5	0.44	
White sucker	222	1.404	65.7	11.0	6.4-16.0	0.68	
Longnose sucker	8	0.051	2.4	-	-	-	
Stonecat	34	0.215	10.1	-	-	-	
Yellow perch	1	0.006	0.3	-	-	-	
Carp	2	0.013	0.6	-	-	-	
Flathead chub	31	0.196	9.2	-	-	-	
TOTAL	338	2.137					

Appendix Q. Hauser Lake (Missouri River) gill netting summary by species sampled. Net sets made 6/15/78 through 6/16/78, 6/26/78 through 6/30/78 and 7/19/78 through 7/20/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	30	0.072	1.4	19.0	7.0-26.7	2.83	25
Rainbow trout	38	0.091	1.8	13.7	10.9-19.4	0.97	(415.58)
Mountain whitefish	15	0.036	0.7	-	-	-	
Yellow perch	60	0.144	2.8	-	-	-	
White sucker	1404	3.378	66.1	13.6	8.6-18.9	1.20	
Longnose sucker	575	1.384	27.1	15.6	7.5-19.1	1.61	
Carp	1	0.002	*	-	-	-	
Flathead chub	1	0.002	*	-	-	-	
Utah chub	1	0.002	*	9.1	-	0.35	
TOTAL	2125	5.113					

*less than 0.1% of sample

Appendix R. Lake Helena (directly connected with Hauser Lake via Prickly Pear Creek) gill netting summary by species sampled. Net sets made 7/17/78 through 7/19/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Net Sets (hours)
Brown trout	3	0.018	0.4	8
Rainbow trout	19	0.114	2.8	(166.83)
Yellow perch	21	0.126	3.1	
White sucker	585	3.507	86.9	
Longnose sucker	13	0.078	1.9	
Carp	31	0.186	4.6	
Utah chub	1	0.006	0.1	
TOTAL	673	4.034		

Appendix O. Canyon Ferry Water Fowl Development (dust abatement project ponds) gill netting summary by species sampled. Net sets made 7/23/78 through 7/25/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Net Sets (hours)
Brown trout	1	0.018	0.3	4
Rainbow trout	1	0.018	0.3	(55.08)
Mountain whitefish	9	0.163	2.3	
Yellow perch	15	0.272	3.9	
White sucker	253	4.593	65.9	
Longnose sucker	9	0.163	2.3	
Carp	7	0.127	1.8	
Flathead chub	86	1.561	22.4	
Utah chub	<u>3</u>	<u>0.054</u>	0.8	
TOTAL	384	6.972		

Appendix P. Canyon Ferry Reservoir (Missouri River) gill netting summary by species sampled. Net sets made 7/10/78 through 7/14/78 and 7/31/78 through 8/4/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	9	0.018	0.4	19.4	16.7-24.2	2.66	25
Rainbow trout	109	0.224	5.3	13.2	6.6-19.3	1.13	(486.54)
Mountain whitefish	55	0.113	2.7	13.0	8.3-16.2	0.89	
Yellow perch	721	1.482	35.4	7.2	5.3-9.8	0.20	
White sucker	1000	2.055	49.0	11.1	6.7-15.6	0.60	
Longnose sucker	31	0.064	1.5	10.6	6.9-16.0	0.54	
Stonecat	1	0.002	*	-	-	-	
Carp	84	0.173	4.1	-	-	-	
Flathead chub	10	0.021	0.5	10.1	9.3-10.9	0.34	
Utah chub	19	0.039	0.9	8.2	6.2-10.7	0.30	
TOTAL	1039	4.191					

*less than 0.1% of sample

Appendix S. Holter Lake (Missouri River) gill netting summary by species sampled. Net sets made 5/23/78 through 5/26/78, and 9/12/78 through 9/15/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	30	0.082	2.0	18.2	9.1-24.5	2.62	19
Rainbow trout	100	0.274	6.8	14.7	12.7-18.0	1.46	(364.50)
Mountain whitefish	44	0.121	3.0	14.0	6.7-17.8	1.26	
Walleye	28	0.077	1.9	17.8	11.6-25.0	2.49	
Yellow perch	273	0.749	18.5	8.0	5.2-11.5	0.25	
White sucker	694	1.904	46.9	12.4	7.7-17.1	0.91	
Longnose sucker	298	0.818	20.1	12.0	6.4-15.9	0.82	
Carp	12	0.033	0.8	-	-	-	
TOTAL	1479	4.058					

Appendix T. Missouri River (1 mile above Craig) gill netting summary by species sampled. Net sets made 9/22/78 through 9/23/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Net Sets (hours)
Brown trout	1	0.028	0.8	2
Rainbow trout	14	0.392	10.9	(35.75)
Mountain whitefish	4	0.112	3.1	
Burbot	3	0.084	2.3	
White sucker	56	1.566	43.4	
Longnose sucker	<u>51</u>	<u>1.427</u>	39.5	
TOTAL	129	3.608		

Appendix U. Tintinger Slough (Missouri River near Cascade) gill netting summary by species sampled. Net sets made 9/20/78 through 9/21/78.

	Number Sampled	Catch rates per hour	Percent Total Catch	Net Sets (hours)
Yellow perch	53	0.986	26.1	3
Black bullhead	35	0.651	17.2	(53.75)
White sucker	98	1.823	48.3	
Longnose sucker	2	0.037	1.0	
Carp	<u>15</u>	<u>0.279</u>	7.4	
TOTAL	203	3.777		

Appendix V. Black Eagle, Cochrane, and Morony Reservoirs (Missour River at Great Falls)
gill netting summary by species sampled. Net sets made 6/5/78 through 6/13/78.

	Number Sampled	Catch rate per hour	Percent Total Catch	Mean Length (in.)	Range (in.)	Mean Weight (lb.)	Net Sets (hours)
Brown trout	6	0.027	0.5	9.3	6.9-15.2	0.44	13
Rainbow trout	5	0.022	0.4	16.2	12.2-19.0	1.54	(222.84)
Mountain whitefish	1	0.004	0.1	12.0	-	0.57	
Walleye	1	0.004	0.1	14.0	-	0.98	
Yellow perch	20	0.090	1.7	6.9	6.0- 7.9	0.19	
Pumpkinseed	1	0.004	0.1	-	-	-	
Stonecat	2	0.009	0.2	8.3	-	0.22	
Black bullhead	1	0.004	0.1	9.1	-	0.52	
White sucker	1027	4.609	88.5	11.7	6.2-16.1	0.85	
Longnose sucker	95	0.426	8.2	9.3	6.6-15.6	0.45	
Carp	2	0.009	0.2	-	-	-	
TOTAL	1161	5.210					

Appendix W. River Miles and rate of downstream dispersal for Utah chubs from Hebgen Dam.
Utah chubs first observed at Hebgen Lake in 1935.

Location	Distance From Hebgen Dam (river miles)	RATE OF MOVEMENT	
		Utah chubs sampled 1978 (miles/yr)	Utah chubs sampled before 1978 (miles/yr)
Ennis Lake	67.6	-	-
Madison River Sloughs	107.0	-	4.1*
Canyon Ferry (northernmost capture)	161.1	3.7	5.0**
Canyon Ferry Dam	178.6	4.1	5.6**
Hauser Lake (opposite Spokane Creek)	183.3	-	5.2***
Hauser Lake (site of 1978 capture)	189.8	4.4	-
Hauser Dam	194.3	4.5	5.6***
Lake Helena Dam	196.6	4.6	5.6***
Holter Lake Dam	222.8	-	-
Morony Dam	308.1	-	-

*calculated from Graham's 1961 observations (Graham 1961)

**calculated from Badow's 1967 observations (Badow 1969)

***calculated from Nevala's 1970 observation (Holton 1978)